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Mind Over Muscle: BCI Technology Erasing and
Transcending the Barriers for the Physically Disabled

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The year is 2075. You remember back to when you were a child and Brain/Computer Interface (BCI) research was just beginning. All the scientists had, what seemed to be at the time, futuristic ideas about the therapeutic possibilities of their research. They wanted to create ways for physically disabled people to have a large measure of control over their lives and be able to function without the help of others around them. Whether you had lost your arm in an accident or war, or you were completely immobile, researchers were beginning to explore the capabilities to give you back some individual mobility. You look around today and see how far the technology has come. Walking down the street, you cannot tell who is missing a limb, who is paraplegic, or even who is quadriplegic just by looking at them. Their BCI technology is tightly compressed around their skin through special clothes, or is connected to their brain, making it virtually invisible to others. This is what the researchers had dreamed of when you were a child. If the technology has come this far in your lifetime, the possibilities for the future of BCI seems endless.

Scientists and developers predict that BCI technologies will provide significant assistance to the physically disabled. This will be achieved through the creation and use of therapeutic suits and prosthetics that are worn under normal clothing, yet controlled by thought. Through the use of these technologies, individuals will be able to transcend the limitations of their disabilities.

Brain/Computer Interface (BCI) technology started as just a dream, and it wasn't until the 1950s that those dreams became reality. Serious exploration, however, did not begin until the 1970s when the Defense Advanced Research Projects Agency (DARPA) received funding for the research. The major developments that are the foundation of BCI technology were made during the next two to three decades. From the 1970s to present day, researchers have made significant advancements and innovations in the development of BCI, such as cochlear implants,

while also applying it to Assistive Technology (AT). According to Felip Miralles, a writer for *The Scientific World Journal*, many researchers have been “motivated by the aim of restoring independence to individuals with severe disabilities, the focus has centered on developing applications for communication, movement control, environmental control, locomotion, and neurorehabilitation” (Miralles 1). This research follows a path that eventually will bring us, as a species, to the next level of quality for our lives – to a place of transcendence.

The main group behind these ideas refer to themselves ‘transhumanists.’ As Joel Garreau, the author of *Radical Evolution*, defines them, “Transhumanist are [those who are] keen on the enhancement of human intellectual, physical and emotional capabilities, the elimination of disease and unnecessary suffering, and the dramatic extension of lifespan” (Garreau 231). Now, with BCI technology strongly in place, scientists are trying to decode the human brain and apply their findings to breakthrough technologies for the benefit of generations to come.

With new BCI technology afoot, we see that it is advancing and transcending past the original physical reality for those who are physically disabled. A lucky select few were able to try either the new surgical procedures, or the non-invasive helmets that can interpret human brainwaves as an alternative. In our first case, taking place back in 2012, researchers developed one of the first few prototypes for a robotic, BCI controlled prosthetic arm. Through an invasive procedure, John Hewitt from ExtremeTech explains that, “... quadriplegic Jan Scheuermann had two electrode arrays implanted in her brain’s left motor cortex. Within a week, she could use the implant to move a prosthetic arm in all three dimensions, and move its wrist in an additional four. That was good enough for her to use it to feed herself with the arm...” (Hewitt 1). For Scheuermann to be able to feed herself was a huge emotional and mental journey. She never thought she would be able to control something to feed herself – a simple task that most people

take for granted every day. Being able to go beyond what she used to consider as her own limitations keeps the idea of BCI transcendence alive, while pushing and motivating scientists to keep working to find the ultimate way to improve the overall quality of life for those with physical disabilities.

In another case, a man from Colorado named Leslie Baugh, was the first person to have a procedure performed that reassigned nerves in his chest. The movement of these nerves made it possible for Baugh to move a prosthetic arm just by thinking about it. In 2014, Baugh had “... a relatively new surgical procedure that reassigns nerves that once controlled the arm and the hand,” explained Johns Hopkins Trauma Surgeon Albert Chi, M.D. ‘By reassigning existing nerves, we can make it possible for people who have had upper-arm amputations to control their prosthetic devices by merely thinking about the action they want to perform’” (Neurogadget 1). Baugh, who lost his arms from the shoulder down, was in a serious electrical accident over 40 years ago, and has lived the majority of his life as an amputee. For Baugh, this was an incredible experience to participate in. Having the prosthetics implemented, made something as simple as putting change in a soda machine for himself, possible. This was an amazing step into his new found freedom.

Since these technologies are now out in the world, it is only a matter of time before other scientists, researchers, and companies begin to try to recreate them or even surpass them. Once this happens, there will be an ever increasing chance of more technological breakthroughs. The dream many scientists have, is to provide the support physically disabled people need to walk and live independently through the use of BCI prosthetics and Smart Homes, simply by using their mind over their muscles.

To further explore the possibilities of BCI transcendence, the European project, BackHome, began. Miralles describes the BackHome project as, "... system[s] [that are] comprised of ergonomic and hassle-free BCI equipment; one-click software services for Smart Home control, cognitive stimulation, and web browsing; and remote telemonitoring and home support tools to enable independent home use for non expert caregivers and users." Miralles goes on to say the goal of the BackHome project is to introduce Brain/Computer Interface technology "to the home of people with limited mobility to restore their independence and ultimately improve their quality of life" (Miralles 1). The introduction of BCI technology to people's homes transcends the possibilities revolving around the ideas of independence that the physically disabled once had.

Flashing back to the 2014 FIFA World Cup in Brazil, a young man who is paralyzed from the waist down, provided the most influential kick of the game. After being driven out on to the field, this young man was able to send his thoughts through a cap filled with sensors, to an exoskeletal suit, which then moved his leg, delivering the opening kick that was being watched by billions of soccer fans around the world. The men who designed this suit are Dr. Miguel Nicolelis, a professor of neuroscience at Duke University, and electrical engineer, Gordon Cheng. Together they worked to create and lead the Walk Again Project. In a video reported by Sanjay Gupta from CNN, Gupta notes, "It's not just about walking, but coordinating brain signals, muscle movements, and spinal cord activity, and having all of that end with a kick" (Smith). Using a noninvasive option, the young paralyzed man was covered in sensors from head to toe. All the sensors worked together to decipher his brain waves and turn his thoughts into a physical movement. While this was a huge step in the right direction, this first BCI exoskeletal suit was just the beginning. Dr. Miguel Nicolelis, Gordon Cheng, and their Walk Again Project

team had only eighteen months to complete the suit before presenting it on an international stage. If they had been given more time and funding, the possibilities for a slimmer, faster, and more precise suit would have been plausible. However, now that the team has the rough model out, work on advancing the technology is continuing.

While many scientists focus on the therapeutic applications of BCI, others are transcending their ideas to directly apply them to people who are still fully mobile. One of the major aspects of life that researchers are trying to apply BCI technology to is the military. A government funded project run by DARPA called, “Silent Talk,” focuses on creating cutting-edge, military-grade BCI technology filled helmets.

‘Silent Talk’ is a DARPA (Defense Advanced Research Projects Agency) initiative, funded by the government to produce a non-invasive BCI helmet that would allow soldiers to communicate silently with only their thoughts. The technology would work by detecting ‘pre-speech’ word-specific neural impulses, analyzing them, then sending the information to the receiving partner(s). (“Super Soldiers” 1)

As Ian Kotchetkov, a writer for Medscape, explains, DARPA’s main goal for these “Silent Talk” helmets is for “... future generations of auditory and visual neuroprosthesis [to] allow soldiers to perform better during combat situations through automated detection and interpretation capabilities” (Kotchetkov 4). If implemented, this technology could save hundreds of thousands of American soldiers’ lives. Instead of responding and acting on verbal command, their brains would detect the thoughts and sights of other soldiers, causing them to be influenced without ever having to speak. In high pressure and dangerous missions, this technology would give American soldiers a significant advantage compared to their enemies.

In addition to those who are physically disabled due to birth conditions, accidents, or amputations, BCI technology could also be applied to the Wounded Warriors programs for those

who have served in the United States Military, and either lost limbs or are now immobile from being in the service. This is a direct application of BCI technology that would benefit some of America's bravest citizens.

Understandably, Brain/Computer Interface technology is, and will continue to transcend human physiology as we know it. Jonah Lehrer, a writer for Seed Magazine, notes that both scientists and researchers have successfully "...constructed elegant models of human consciousness that manage to express the texture of our experience, distilling the details of real life..." (Lehrer 3). However, Garreau shows that BCI technology has the opportunity to deny that idea by arguing that, "...human nature is fundamentally bounded by our own genetically determined, species-specific patterns of behavior," (Garreau 239) and that we *can* go beyond what our genetic patterns have determined for us. The transcendence of BCI technology defies the idea that human nature is the only path we have to follow.

Brain/Computer Interface technology will continue to evolve as we, as a species, evolve and strive to make the world a better place for all. However, by having BCI in our society, and continuing to make it an aspect of everyday life, many ethical questions arise. Those who are against the ideas sprouting from the transhumanists, ask questions like: should anyone, even soldiers, be able to communicate telepathically? Is it really okay to have a "bionic man" amongst us? Will that create unfair advantages? Would it be possible to hack someone's mind if they had a BCI implant? Are they still classified as "human" if they have BCI implants? Does the introduction of this technology impact what we consider to be "human nature"? Garreau chimes in again and addresses some of these concerns. "With the rise of the genetic, robotic, information, and nano technologies, ... we're talking about remaking this container. This is why it is so important to figure out what's up with human nature now" (Garreau 239). Garreau uses

the word “container” to identify the many varying ideas that make up the definition of human nature. While the definitions of human nature vary, the majority of them do not include implanting technology into our brains, and for many people, the transcendence of BCI is a terrifying idea.

What may have started out as a wish to have the world see the greatest kick in soccer history, or simply giving an arm amputee the ability to put coins in a soda machine by himself, now has an infinite amount of prospective paths. While researchers, scientists, and developers are still getting their rough ideas regarding BCI out on paper, the potential for life changing inventions is right around the corner.

The future of brain–computer interfaces depends upon multidisciplinary collaborations among neuroscientists, psychologists, clinicians, engineers, and mathematicians, and upon ongoing communication with relevant stakeholder communities including regulators, physicians, and patients. Effectively bringing together these diverse fields and communities will facilitate the development of new tools to measure, quantify and model dynamic, multi-scale brain activity and will ultimately lead to novel therapeutic regimens and training paradigms capable of restoring and improving neural, cognitive, and behavioral function. (Miranda 14)

The possibilities for improving the quality of human life, and the length of human life are endless with the use of Brain/Computer Interface technology. Including Jonah Lehrer, many believe that "...scientific knowledge is a linear ascent. The history of science is supposed to be a simple equation: time plus data equals understanding." Lehrer continues on to say, “One day, we believe, science will solve everything” (Lehrer 1). The transcending ideas that surround BCI will only grow over time, pushing people out of their comfort zones, and into the exciting world of science and technology. There will always be questions of what is right, and what is wrong. Yet, if people don’t push the boundaries of what is possible, and hold on to those new ideas, how will

we be able to save and enhance the potential proficiency of human lives? How will we be able to transcend as a species, and more importantly, should we?

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